Deviation displayed

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THE UNIT TO BE DESCRIBED, which gives a display of negative and positive deviation from the centre frequency, was designed to operate from the i.f. of an fm receiver, but, with a suitable front-end it could equally well be used to monitor a transmitter. It consists of a discriminator working directly into a display unit, and can be battery operated. The MP5071 (or its equivalent, the MC3357) was chosen because this ic not only has a limiter and a discriminator but also contains a local oscillator and mixer—it has already been more fully described in [1]. The frequency of this local oscillator is determined by an external crystal or LC tuned circuit, so that most i.f. frequencies can be accommodated. Thus for an i.f. of 10·7MHz a crystal with a frequency of 10·245MHz is needed, as the discriminator is tuned to a centre frequency of 455kHz. The quadrature coil is an LMC4200A designed for a centre frequency of 455kHz. It is resonated to the i.f. by an internal capacitor; precise frequency setting is by an iron dust core. A 455kHz input would be applied through pin 5 directly to the limiter. Fig 1 shows the trial circuit. When a stable 455kHz oscillator was applied, the resulting voltage output at pin 9 is as shown in Fig 2.

It is clear that the "Q" of the LMC4200A is too high, giving poor linearity of the "S" curve versus deviation. The sensitivity can be reduced, and the linearity much improved, by shunting the LMC4200A with a resistor. Fig 2 also shows the result when this is done for a value of 15kΩ. If a suitable meter is coupled to pin 9, through an i.f. filter, steady state deviations are readily displayed, but of course the meter cannot respond fast enough to follow audio modulation. It is essential to preserve the dc coupling if the unmodulated carrier reading is to be retained so that frequency deviations can be distinguished. Negative and positive excursions of deviation can be obtained if a diode is included in the meter circuit, and the other meter terminal connected to an adjustable off-set voltage so that a zero reading can be obtained with the unmodulated carrier. Reversing the diode will allow the reverse deviation to be indicated.

Near peak deviations can be displayed if the meter is shunted by a capacitor in the microfarad range, provided that sufficient current is available to fully charge the capacitor while the peak deviation lasts. It was found that a fairly large output amplifier was needed. There is a further disadvantage in the meter display—the voltage delay before the diode is fully conducting. Fig 3 shows the circuit stage reached before the method was abandoned.

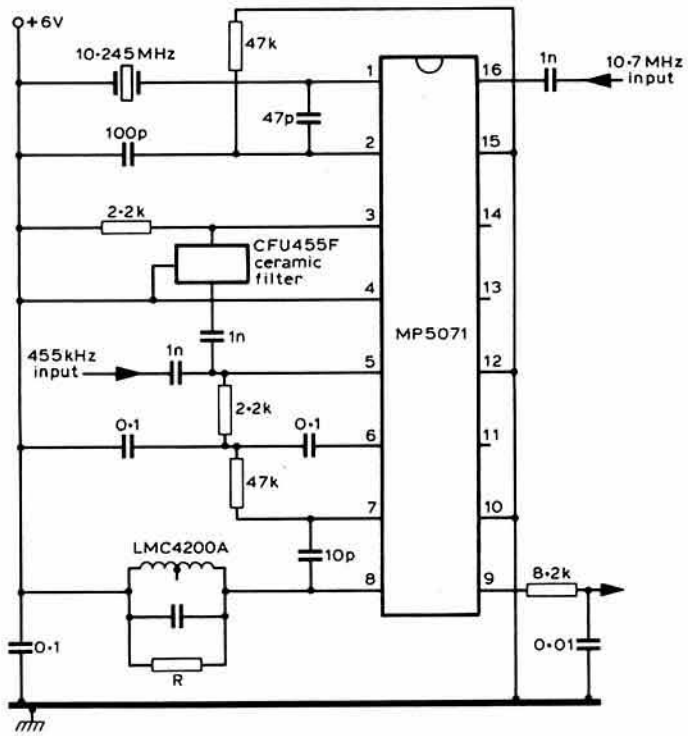

Fig 1. Trial circuit for the MP5071

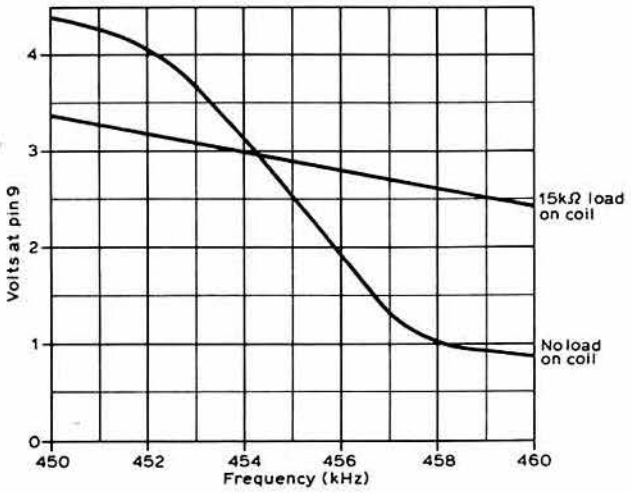

Fig 2. Discriminator response with 455kHz input

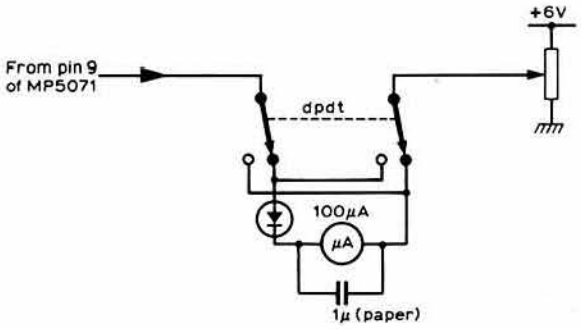

Fig 3. Peak meter circuit

A reconsideration of the practical use to which the deviation display unit might be put suggested that a line of l.e.ds might be adequate. The discrimination of such a display is limited by the fact that the driver ic (the LM3914) tends to switch from one l.e.d. to the next with little change in

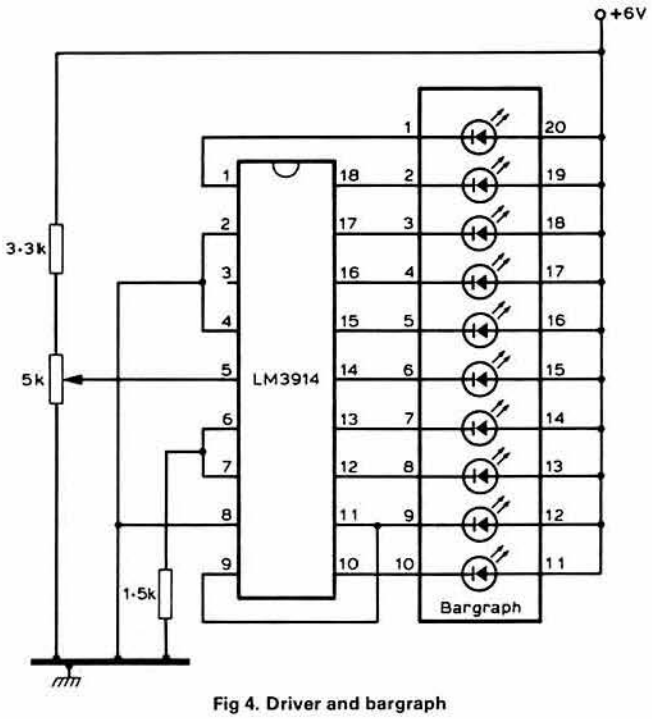

Fig 4. Driver and bargraph

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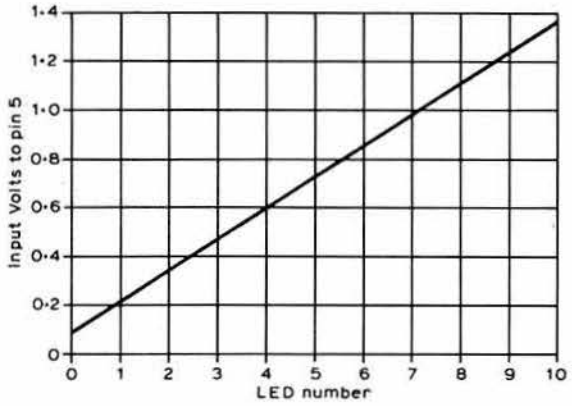

Fig 5. Driver and bargraph response

Components list

R1, 5	47kΩ	C1	100pF
R2, 3, 4	2·2kΩ	C2	47pF
R6	15kΩ	C3, 4, 6	1nF
R7	8.2kΩ	C5	220pF
R8	1kΩ	C7, 8, 10	0·1μF
RV1	470Ω sub-min preset	C9	10pF
RV2	4·7kΩ or to suit range required	C11	0·01μF
		L1	LMC4200A 455kHz quad coil (Ambit)
IC1	MP5071 or MC3357 (Ambit)	FL1	CFU455F
IC2	LM3914 (Maplin)		

20-dil 10-l.e.d. bargraph (Maplin)
Low-profile ic holder 20-pin dil (Ambit)
Low-profile ic holder 18-pin dil
Low-profile ic holder 16-pin dil

HC25U 10·245MHz crystal and holder if required

Note: All resistors are 0·33W, and all capacitors are miniature ceramic plate

brightness once an l.e.d. operates. If the unmodulated carrier is made to light the centre l.e.d. by means of an off-set voltage control, then both negative and positive deviations can be displayed apparently together, since the eye retains the impression for some twentieth of a second. While a line of standard full-size l.e.ds may be best for viewing on a shelf in the shack, the encapsulated bargraph, available in a 10-l.e.d. 20-pin dil package, is very convenient for a hand-held unit. Fig 4 shows the test circuit for an LM3914 connected to a bargraph.

The LM3914 10-l.e.d. driver contains 10 comparators, each controlling a single l.e.d.. The negative inputs of the comparators are connected in parallel, through a buffer stage, to the signal input at pin 5, but the positive inputs are connected to consecutive points on a potentiometer chain so that their bias voltages increase by equal steps. This means that as the signal voltage rises, one l.e.d. after another is switched on. Fig 5 shows the response curve. Pin 9, the mode pin, enables l.e.ds previously switched on to remain illuminated or switched off as required, thus giving a bar or dot display. For a bar display the voltage on pin 9 must be within 20mV of the supply, and for a dot display 200mV or more below that of the supply. However, if the voltage on pin 9 falls below the supply by 0·9V or more, then l.e.d. No 10 will be turned off.

The ends of the potentiometer chain are brought out to pins 6 and 4 so that the total voltage across the chain may be altered, thus altering the sensitivity. A further voltage may be introduced between the lower end of the chain and the negative of the supply, thus delaying the start of the action until a certain signal voltage has been reached. A suitable reference voltage is available from pin 7, giving a maximum of about 1·3V between pins 7 and 8. The total value of resistors between pins 7 and 8 determines the l.e.d. current and therefore the brightness. The LM3914 is therefore a very versatile ic.

Tests were then conducted to find out the conditions required for interface between the MP5071 and the LM3914. Fig 6 shows the initial test circuit. Looking back to Fig 2 it is clear that the output of the MC5071 varies by about 1V when the oscillator frequency changes from 450 to 460kHz, ie 455 ± 5kHz, and that an off-set voltage of 2·5V was required. The 470Ω preset and the 5kΩ variable easily enable this to be met. With a synthesized receiver, however, the i.f. frequency will vary more than this range because the receiver can only be tuned to the nearest 5kHz. Even repeaters working on multiples of 5kHz have been found to vary by a 1kHz or so, while stations working simplex can cause wide variations in the i.f.. Fortunately the off-set voltage control was found to be adequate to cope. In fact the unmodulated carrier could be set to illuminate the l.e.d. at one or other end of the scale, thus making full use of the linear range of the discriminator. The overall sensitivity was set at 1kHz per l.e.d., but it can be altered either by the 470Ω preset or the resistor in parallel with the discriminator tuned circuit (LMC4200A).

When the unit is supplied with a 10·7MHz signal at pin 16 and a 10·245MHz crystal inserted in the local oscillator circuit, the sum and difference frequencies, ie 20·945 and 0·455MHz, are created at pin 3 and the filter prevents the higher one from reaching the limiter at pin 5. This situation was imitated by feeding a 455kHz oscillator signal into pin 3 via a

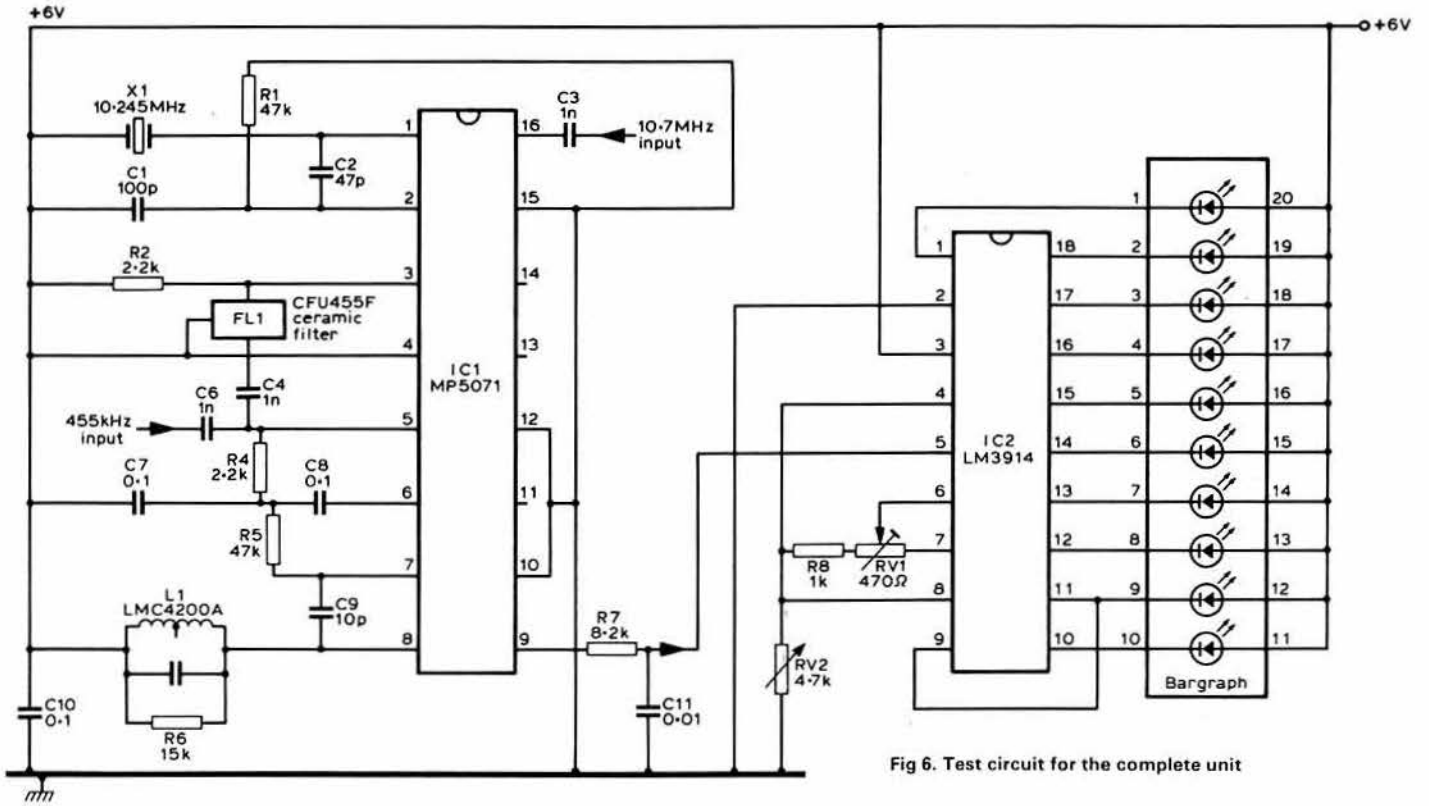

Fig 6. Test circuit for the complete unit

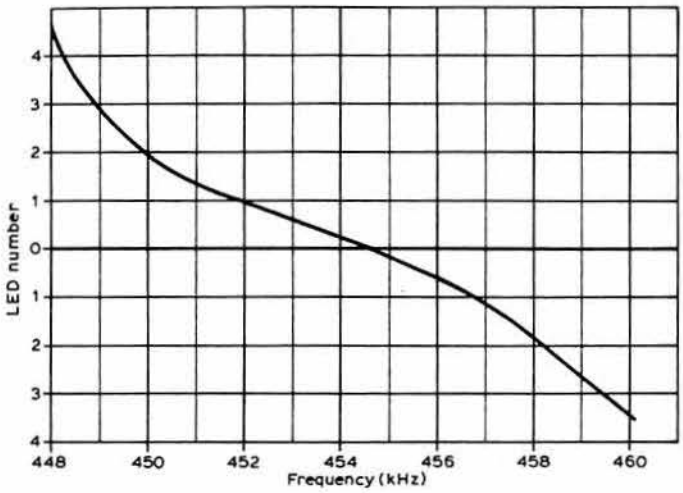

Fig 7. The effect of passing a 455kHz signal into pin 3, ie through the ceramic filter

1nF capacitor. The response is shown in Fig 7, and is far from linear. The trouble was traced to the ceramic filter, which was then removed and tested in the circuit shown in Fig 8. As the oscillator was tuned across the passband the waveform moved along the time-base over a distance equal to about $3\lambda/2$, ie a phase change of some 540° had been produced by the filter. The filter was then replaced by the simple RC filter shown in Fig 9, which also shows that the response had once more become linear. The RC filter reduces the 455kHz signal by about 6dB, but the 20·945MHz signal by much more.

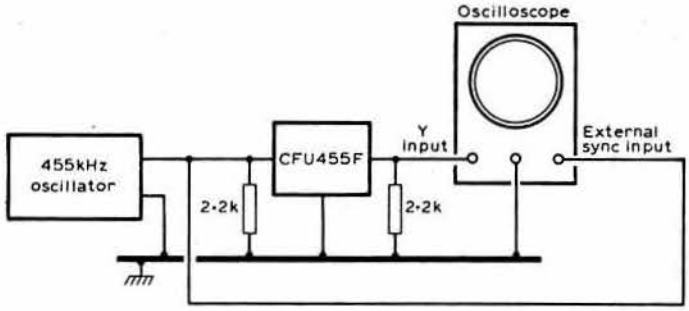

Fig. 8 Filter test circuit

Calibration is simplicity itself, as it can be carried out in steady-state conditions simply by reading the oscillator frequency on a dfm as each l.e.d. changes to the next when the oscillator is tuned across the band. When used with a 144MHz receiver the range of deviations viewed has to be seen to be

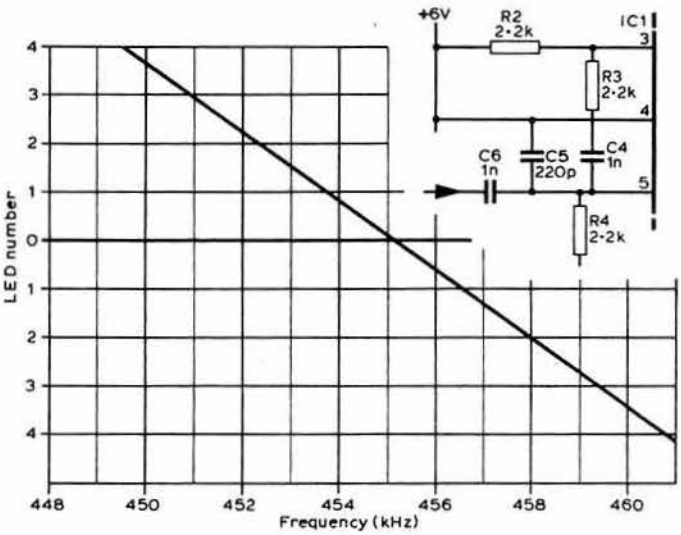

Fig. 9 Ceramic replaced by RC filter

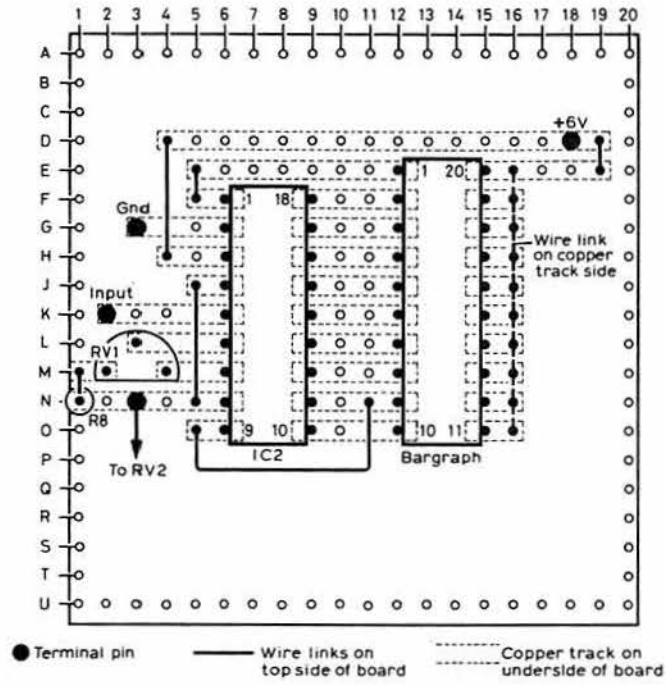

Fig 10. Display board layout

believed! The total current consumption from a 6V supply is about 24mA, and so can be supplied from a 9V battery of the PP6 type when used with a 6V zener and suitable series resistor. The peak voltage required at the 455kHz input is of the order of 100–200mV, while the data suggests that a 10·7MHz input at pin 16 need only be about 10μV.

Constructional details

The components were mounted on two pieces of Veroboard. A piece having a matrix of at least 20 × 20 holes was used to mount the bargraph display together with its LM3914 driver and associated components. The top and underside views of this board are given in Fig 10. A second piece having a matrix of at least 20 × 24 holes, with the copper strips along its length, was used to mount the discriminator, coil, crystal holder and other components. The top and underside views are shown in Fig 11.

For bench use the display panel was mounted on the underside of the lid of a metal box 6 by 4 by 2in, and the bargraph viewed through a rectangular window cut in the lid and fitted with a viewing hood. The off-set voltage control potentiometer and on-off switch were also mounted on the lid. The

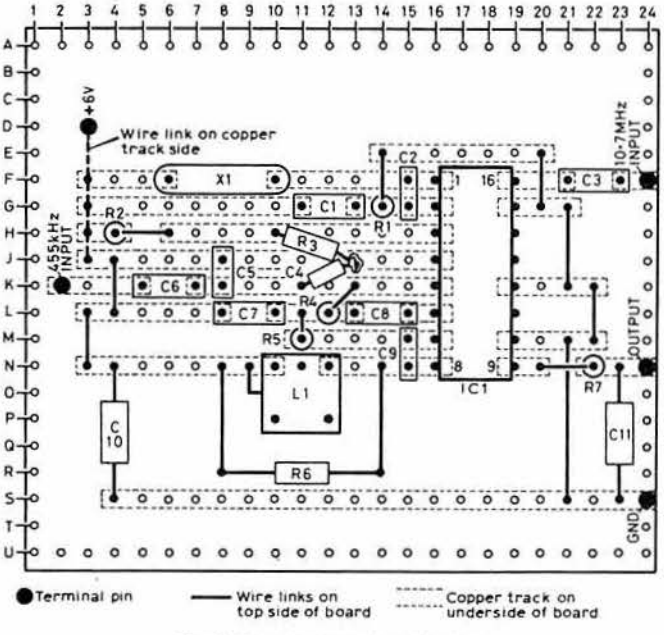

Fig 11. Discriminator board layout

second Veroboard was mounted on the bottom of the box, the two boards being connected by flying leads long enough to allow inspection. The PP6 battery was restrained by a wooden partition.

For shelf use it might be better to mount the display panel on one side of the box.

The sections of copper strip under the Veroboard not in use need, of course, to be disconnected from those that are in use. This is best done with the cutting tool designed for the purpose. Particular attention needs to be given to the mounting of the LMC4200A. No contact must be made with the pair of pins on the side remote from the three-pin side, and the centre pin of the three-pin side must also not make contact. These conditions are easily met by means of the cutting tool. The below board wire links are soldered to the copper strips they are meant to connect and isolated from all others.

Reference

[1] "A narrow-band fm receiver using a Motorola MC3357", I. J. Dilworth, G3WRT. *Rad Com* June/July 1980

Multiple hf parallel dipoles—some further thoughts

by E. SQUANCE, TD, BSc, PhD, GI4JTF*

THIS WORK came out of a requirement for multiband operation in a space where a conventional trap dipole had given poor results due to its low height (15ft/4·57m) and its proximity to buildings. A study of likely alternatives unearthed the idea of multiple parallel dipoles (1) + (2) for 7, 14 and 28MHz.

Initial tests using the formula $\frac{468}{f}$ to calculate the dipole elements' lengths gave very poor swr readings and resonances outside the amateur bands as determined by a Cambridge Kits noise bridge. A chance discussion on 7MHz with G3IYG made it clear that for a similar indoor system the elements had to be lengthened.

The Mk2 antenna had elements which were cut 2ft/61cm longer than the Mk1, and these were trimmed to resonance using a noise bridge and swr meter. From the resonant frequencies and dipole lengths the formulas shown in Table 1 were determined with the antenna at 35ft/10·7m. In passing it is interesting to note that at ground level the 7MHz dipole tuned 50kHz lower, the 14MHz dipole 100kHz lower, and the 28MHz dipole 325kHz lower.

The dimensions of the antenna appear to be the cause of the interaction, and the details are as follows. The wire used was multi-stranded 2mm copper wire spaced every 2ft/61cm by old felt-tip pen bodies cut and drilled as shown in Fig 1, which also shows the general construction.

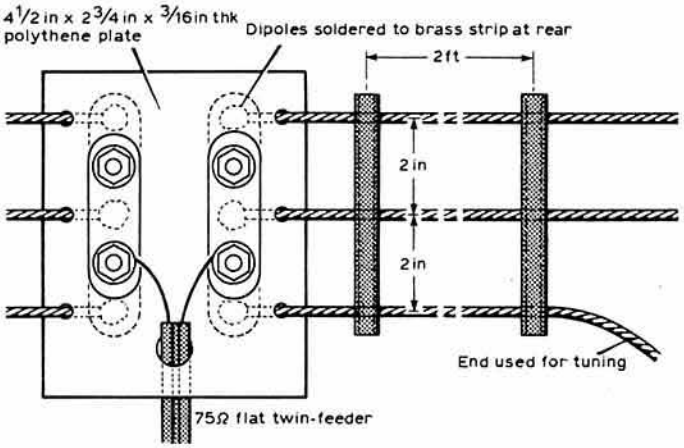

Fig 1. Arrangement of feeder and wires on base, and of spacers on wires

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Table 1

Resonant frequency (MHz)	Length of dipole (ft/m)	Revised formula
7·050	67·50/20·57	476/f
14·250	33·82/10·31	480/f
28·775	16·67/5·08	479/f mean value 478/f

For close spaced (2in/5cm) dipoles the formula was $\frac{478}{f}$ not $\frac{468}{f}$, ie an increase of two per cent in element lengths.

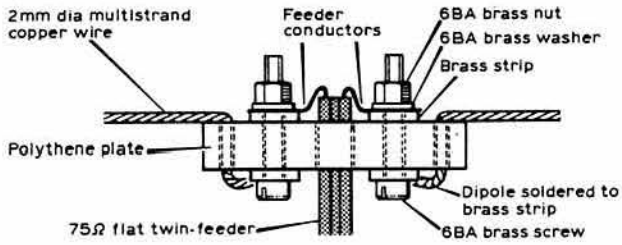

Fig 2. Exploded end-view of centre plate showing mechanical constructional details

For rigidity the wires were fed through the plate and soldered to 2·5 by 0·5in/6·3 by 1·27cm copper strips which were bolted to the plate. A second copper plate was placed on the back to prevent the nuts pulling through and against which to bolt the feeder. The feeder was passed through the plate from front to back to prevent it whipping in use. This can best be seen in Fig 2. The base plate was polyethylene 4·5 by 2·75 by 0·19in/11·4 by 6·9 by 0·5cm.

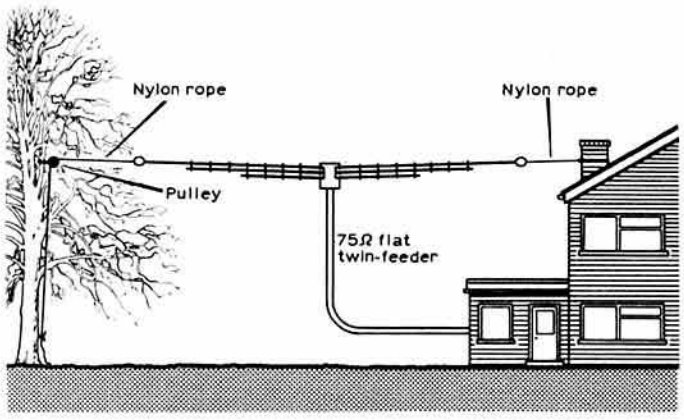

Fig 3. Position of antenna relative to house and shack

The whole assembly was liberally coated with marine varnish before being hoisted to its working height. The antenna was rigged as shown in Fig 3. Since December 1980, when the antenna was commissioned, JA, VKs, LUs, and HSs have been worked on 28MHz and 35 countries on 7MHz ssb. Although not mentioned in the data, the antenna performs well on 21MHz, with some 67 countries being worked without an atu, and an swr of 1·8:1 across the band.

Bibliography

[1] *Radio Communication Handbook* Vol 2, pp12.62, 12.63.
[2] "A multiband dipole for the hf bands", W. Farrar, G3ESP. *Radio Communication* June 1979, p527.